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Perceptions of Technology Education Supervisors toward Implementation of Engineering by Design Courses in Virginia Public Schools

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PERCEPTIONS OF TECHNOLOGY EDUCATION SUPERVISORS TOWARD IMPLEMENTATION OF *ENGINEERING BY DESIGN* ™ COURSES IN VIRGINIA PUBLIC SCHOOLS

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SIGNATURE PAGE

This research paper was prepared by Terrance M. Beddow under the direction of Dr. John M. Ritz in OTED 636, Problems in Occupational and Technical Studies. It was submitted to the graduate program director as partial fulfillment for the requirements for the Master of Science degree.

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CHAPTER I

INTRODUCTION

Research has shown that amidst a technologically advancing world, American schools have struggled to produce technologically literate students. Regardless of increased involvement at the state and federal levels, infusion of technological literacy with related engineering concepts has been inconsistent (Pearson & Young, 2002). In 2006, Ritz recognized a need for educators in engineering circles to increase their awareness to the efforts made by technology education professionals that incorporate basic engineering concepts into their curriculum. However, Wulf (2007) noted that inconsistencies continued to exist between engineering and technological literacy throughout the K-12 levels.

With the assistance of the International Technology Education Association's Center to Advance Teaching in Technology and Science (ITEA-CATTS), opportunities became available to forge relationships between the researchers and the practitioners (Burke & Meade, 2007). To date, 18 states have implemented ITEA-CATTS *Engineering byDesign*™ (*EbD*™) courses (B. Burke, personal communications, February 25, 2009). Recently, Virginia regained status as an ITEA-CATTS consortium participant state, which includes, among others, access to *EbD*™ curriculum as a benefit of membership (Engineering byDesign, 2007). Given the current consortium status, the rationale for this study was to determine if local supervisors in Virginia school systems plan to implement *EbD*™ courses into their program offerings.

Although many technology programs have been created and implemented by innovative educators in recent years, the content contained within state competencies still varies from the *Standards for Technological Literacy* content (Virginia Department of Education, n.d.; ITEA, 2007). In some areas of the United States, technology education programs are either non-existent or they are not viewed as purposeful in the minds of some educators. According to Hanson, Burton, and Guam (2006), viewpoints have differed among educators as to what constitutes an effective technology education program despite collective efforts to provide quality instruction.

Technology education as a school subject has gained some relevance in recent years given its inherent tie to engineering. However, technology education was left to the discretion of individual states, while efforts to increase the value placed on technology education largely remained inconsistent (Meade & Dugger, 2004). In some cases, curriculum development efforts have prospered, while others have resulted in discontinued course offerings; yet still other have relied on textbooks vice updated curriculum (J. Ritz, personal communication, March 15, 2009).

The major reason for conducting this study was that Virginia had not developed much curriculum for technology education in the past decade. Since the ITEA took action to develop curricula based on content standards for consortium states (e.g., Virginia) to use, the question of implementation remained unanswered. An important goal of the study was to become aware of Virginia district supervisor intent toward *EbD*™ implementation. Other research goals were to describe local supervisor's opinions about choosing such courses to integrate in their local programs. The desire to examine the perceptions of Virginia technology education supervisors toward implementation of *Engineering byDesign*™ courses led to the problem of this study.

STATEMENT OF THE PROBLEM

The problem of the study was to determine the perceptions of Virginia technology education supervisors toward implementation of *Engineering byDesign*™ courses in Virginia public schools.

RESEARCH QUESTIONS

The following research questions were developed not only to establish the boundaries for this study, but also to guide the researcher toward possible solutions to this problem.

- How aware are Virginia technology education supervisors of the ITEA-CATTS *Engineering byDesign*™ courses and their curriculum?
- Which ITEA-CATTS courses do local Virginia technology education supervisors believe could be implemented in their districts within the next five years?
- What needs to occur for Virginia school systems to implement the *Engineering byDesign*™ courses?

BACKGROUND AND SIGNIFICANCE

Many technology transitions and trend-setting changes have occurred in the past two decades. Despite strong support from leadership, technology education curricular offerings continued to follow societal norms in terms of preparing students for the knowledge needed to become productive members of society (Dugger, 1994; Foster, 1994; Valesey, 1998). As technology education evolved, transitions from the post-industrial era were slow in terms of philosophical changes, curriculum modifications, and revised goals. Even though educators engaged in public campaigns to raise awareness for the need to change curriculum, society oftentimes had the greater influence on what was taught in schools. Volti (2006) noted that the amount of skill training needed by workers was “strongly influenced by the principal technology” used by the organization (p. 287). One might question how the knowledge and education of a student should maintain pace in an industrialized world that increasingly became technologically advanced.

On the world stage, the need to produce workers to maintain one’s own livelihood was no longer the necessity; rather, it became increasingly important to maintain an intellectual pace with other countries of the world, which seemed to be surpassing the United States on every level (Pearson & Young, 2002). Creation of the *Standards for Technological Literacy* was an important step towards becoming a specialized area within K-12 education. Content standards development also provided a means by which various disciplines such as mathematics, science, and engineering could be compared with technology education to synthesize four disciplines into what is now referred to as STEM (Science, Technology, Engineering, and Mathematics) (Custer & Erekson, 2008).

In an effort to increase the importance of technology education, numerous researchers and technology educators (Lewis, 2005; Meade & Dugger, 2006; Pearson, 2004; Ritz, 2006) advocated for the academic benefits that resulted from linking science, technology, engineering, and mathematics disciplines. Many excellent programs were developed by professional organizations that included curriculum materials and delivered technological content to students amidst ideological change (Burke & Meade, 2007). In response to issues of relevance, *Engineering byDesign*™ and *Project Lead The Way*™ were two pre-engineering curriculum products that had emerged (Meade & Dugger, 2006).

The *Engineering byDesign*™ model curricular offerings were comprised of courses for each K-12 grade level. For the elementary grades, *Integrated Concepts and Lessons* were developed to introduce basic technology concepts to the K-2 and 3-5 grade level students. For the middle school grades 6-8, three programs were developed that included *Exploring Technology*, *Invention and Innovation*, and *Technological Systems*. At the high school level (grades 9-12), there were four curricula developed with increasing academic rigor and titled as follows: *Foundations of Technology*, *Technological Issues and Impacts*, *Technological Design*, and *Engineering Design*. The curricula provide students with an understanding of technological concepts infused with engineering content. The CATTS curricular offerings (*EbD*™, 2007) can be implemented as units, individual courses, or in their entirety as an integrated, standards-based program for both middle and high school syllabi.

These materials not only had the potential to improve student technological literacy, but they also could incorporate STEM concepts within a standards-based curriculum utilizing content standards as its foundation (Burke, 2005; Sneider, 2008). As an example, Dearing and Daugherty (2004) asserted that design aspects shared between technology and engineering have shown great promise in the same manner as problem solving had existed between engineering and technology education.

Because ITEA-CATTS made available the content standards along with the *Engineering byDesign*™ curriculum, and given status as a CATTS consortium state, the results of this study might determine whether the Virginia technology education supervisors will choose implementation of ITEA-CATTS *Engineering byDesign*™

courses. In addition, this will determine plans that must be designed to enable teachers to implement these courses.

LIMITATIONS

The findings of this research were limited by certain factors and conditions. In this study, the perceptions were acquired from and limited to technology education local supervisors in the Commonwealth of Virginia. The options for implementing standards-based curricula were limited to the ITEA-CATTS *Engineering byDesign*™ courses. The research study did not examine curriculum offerings available within each district. However, the data received did consist of written, verbal, and online correspondence with Virginia district supervisors in charge of technology education programs. In addition to survey correspondence, pilot study assistance was afforded to the researcher by STEM Education and Professional Studies faculty at Old Dominion University.

ASSUMPTIONS

The assumptions included in this study were necessary not only to identify and clarify the problem, but also to establish those items that the researcher believed to be true and unalterable with regard to the study. Virginia has not updated its curriculum consistently to incorporate the content standards contained within the *Standards for Technological Literacy*. Virginia became an official member of the ITEA-CATTS consortium of states in 2008. The researcher assumed that this membership conveyed a formal commitment to plan for the implementation of standards-based curriculum within five years. It was also assumed true that technology education local supervisors in Virginia have both the authority and knowledge necessary to effect curricular change within their respective districts. In addition, the respondents would have a genuine interest in maintaining or establishing an effective technology education program.

PROCEDURES

The procedural method for collecting data in this study began with identification of a population from which the researcher could gather data. Although implementation of new technology education curriculum need political and financial support from many levels, the researcher deemed the perceptions of local supervisors, who were degreed in technology education, most important for the purpose of this study.

A questionnaire was developed with specific items that allowed the respondents to reveal their perceptions of ITEA-CATTS *Engineering byDesign*™ course implementation plans within respective school districts. The researcher mailed the questionnaire with an accompanying cover letter and *EbD*™ Postcard to local supervisors of technology education, who were then given ten days to review and reply. Data collection conflicts were resolved using computer email and telephone methods to ensure the highest possible response rate.

Upon return of the survey information, the collected data were organized, tabulated, and displayed in a useable form to illustrate perceptions. The researcher used descriptive statistical methods for presenting the data and stating conclusions in a meaningful way.

DEFINITION OF TERMS

This section provided for clarification of key terms and phrases that had special meaning in the study. The definitions of terms and phrases were specifically provided according to the context of this study.

Content standards — The standards in *Standards for Technological Literacy: Content for the Study of Technology (STL)* that provide written statements of the knowledge and abilities students should possess in order to be technologically literate (ITEA, 2007).

Engineering design — The systematic and creative application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, machines, processes, and systems (ITEA, 2004).

ITEA-CATTS — An acronym for International Technology Education Association-Center to Advance Teaching of Technology and Science, which is an organization that developed the *Engineering byDesign*™ courses and related curriculum. Members of the consortium of states provide a network of support and guidance for implementation.

Local Supervisor — Person in charge of the Technology Education program(s) within their respective public school district. Under the supervision of a state supervisor, these district supervisors make up the community of leaders focused on raising student achievement and improving teacher pedagogical knowledge and skills.

Standards-based — This term refers to educational standards that provide the content basis upon which student learning is built. Everything that affects student learning is planned to support students as they attain standards.

Standards-reflected — This term describes the association with educational standards, excluding standards that do not always provide a basis for student learning. Thus, the teaching and assessment of standards can be inconsistent and dependent upon circumstance (Burke, 2006).

STEM — An acronym for Science, Technology, Engineering, and Mathematics. It is a concept term that signifies an element of integration between the academic disciplines.

<u>Technological Literacy</u> — This term refers to the knowledge that one understands about the various technology-related aspects of the current world. It requires an understanding of the concepts and principles about various aspects of science and technology. It is associated with the skills and capabilities that a person should know and be able to do in order to function in a society rich with technology (ITEA, 2007).

<u>Technology</u> — This term is defined as the innovation, change, or modification of the natural environment to satisfy perceived human needs and wants (ITEA, 2004).

OVERVIEW OF CHAPTERS

This research was organized into five major sections. Chapter I introduced the reader to this descriptive study, which was designed to examine the perceptions of local supervisors toward the implementation of ITEA-CATTS *Engineering byDesign*™ (*EbD*™) courses within Virginia public school districts. The purpose of the study was to describe systematically the characteristics of ITEA-CATTS *EbD*™ course curriculum implementation, which could establish a rationale for further action by Virginia technology education supervisors. The nature and scope of the study outlined the research in a conceptual framework to understand the implications of standards-based curriculum implementation. The motivation for the research sought to understand local supervisor interests and beliefs regarding district implementation of *EbD*™ courses and describe their opinions about choosing such courses to integrate in their technology programs.

This study emerged from a need to understand the importance that local supervisors of technology education placed on *EbD*™ courses as a means to increase the technological literacy of their students. A context between engineering and technology was explored as a means to improve authentic learning. The perceptions of these technology education experts were desired to determine if implementation of *EbD*™ courses in respective districts might occur within five years.

In Chapter II, *Review of Literature*, content will be organized according to descriptors and variables contained within the research goals. An understanding was expanded to include the development of the content standards and how *EbD*™ implemented those content standards. In addition, the trend to include engineering influences in technology education curricula as well as the role of the local supervisor in curriculum change was discussed. Chapter III, *Methods and Procedures*, will include information regarding methods and procedures utilized to gather data. This chapter will provide an appropriate explanation of the statistical data analysis methods used to interpret meaning from the data. In Chapter IV, *Findings*, the descriptive survey data will be quantified and presented. The chapter was comprised of subsections that discussed the response rate and then reported the survey findings, which were grouped in research question order. In Chapter V, *Summary, Conclusions, and Recommendations*, the researcher will summarize the research study by drawing conclusions and making recommendations based on the accumulated data.

CHAPTER II

REVIEW OF LITERATURE

This chapter reviewed literature that established a relationship between *Standards for Technological Literacy (STL)* and subsequent development of *Engineering byDesign*™ (*EbD*™) curricula. Numerous scholarly references provided information needed to understand apparent trends to incorporate engineering influences into technology education curricula. Furthermore, the available *EbD*™ curriculum products were discussed to provide the reader with knowledge of *EbD*™ as an example of content standards implementation. In addition, this chapter aimed to help the reader be aware of the duties and responsibilities of technology education supervisors and leaders with respect to curriculum change.

Content Standards and *Engineering byDesign*™ Curricula

Research has shown that a unique relationship exists between *Standards for Technological Literacy* (STL) and *Engineering byDesign*™ (*EbD*™) (AETL, 2003). The relationship between these two documents not only made it possible for one to define what technology education was, but more importantly, provided an application example of how it could be taught. Current scholarly sources described how the development of *EbD*™ by the ITEA-CATTS organization had originated to show practitioners and educators how to implement the standards (Morrow, Robinson, & Stephenson, 2004).

While education in the United States had been and continues to be a responsibility of the individual states, Smith and Burghardt (2007) advocated for the infusion of instructional materials using *Engineering byDesign*™ courses to increase content rigor.

As discussed in the next section, the impacts of the content standards have affected many new programs (ITEA, 2006).

The Impact of Standards for Technological Literacy

After years of research, ITEA released the *Standards for Technological Literacy* (STL) in 2000. From a national perspective, these new content standards were instrumental in providing a vision of technological literacy for all students. Additionally, these content standards provided a base from which to develop technology education curriculum. However, the impact resulted in inconsistent changes (Wulf, 2007).

To aid in aligning curriculum with content standards, *Advancing Excellence in Technological Literacy (AETL)* (2003) was released under the direction of the ITEA. Since then, numerous changes have occurred in technology education that had positively influenced curriculum development and implementation, which also began to include engineering content influences (ITEA, 2003; ITEA, 2007).

An increased need for technologically literate employees in the workplace had influenced the decisions made by local supervisors (Shown, 2008). In addition, leaders in the profession have recognized a shift in scope that has generated a desire for curricula that could address engineering content and technology concepts. With respect to curriculum and standards, Custer and Erekson (2008) asserted that an apparent shift toward engineering within the content standards was synonymous with "curriculum efforts around the nation" (p. 268).

External factors and federal legislation, such as the Schools to Work Act (1994), Goals 2000, NCLB (2001), along with the latest version of the Carl D. Perkins Career and Technical Education Act (2006), had influenced the philosophical and curriculum changes occurring in technology education. Furthermore, global support for technological literacy had increased, in part, due to funding by the National Science Foundation (NSF) as well as the National Aeronautics and Space Administration (NASA). According to a team of engineering and technology education faculty, the bedrock purpose for content standards enabled all students in K-12 grade levels to become technologically literate using standards-based curricula (NCETE, 2007).

The movement toward curriculum development using content standards became important for understanding the subsequent changes that followed. In Ritz et al. (2002), Starkweather suggested that the standards movement had begun from the "need to describe the performance that students should attain" (p. 224). However, as times changed, technology became an influential catalyst in the promotion of learning and life skills needed for economic survival in today's society.

From other perspectives, several studies have shown that the lineage of technology education to engineering-related content could be established with design curricula (Becker, Hailey, & Thomas, 2008; Gattie & Wicklein, 2007; NAE, 2000, 2004; Ritz, 2006; Wicklein, 2006). To understand this, one need only to consider the rigorous nature of *EbD*™ curricular materials, which include experiences in technology, innovation, design, and engineering. As explored in the next section, literature aims to draw attention to *EbD*™ curricular experiences as a fundamental approach toward becoming technologically literate. The CATTS materials emphasize a design engineering approach in the creation, combination, repetition, and presentation of design solutions (See Appendix A for *EbD*™ course descriptions).

CATTS and Curricular Materials

Many factors prompted the creation of the Center to Advance the Teaching of Technology and Science (CATTS) in 1998. While the ITEA was committed to its mission to implement content standards, the world was becoming increasingly technological in nature. An organization was needed to strengthen professional development of educators while advancing technological literacy (ITEA, 2007). To ensure accurate curriculum development, ITEA led the way with the creation of its own standards-based curriculum called *Engineering byDesign*™. Many have purported that ITEA-CATTS curriculum addressed the content standards. ITEA (2006) wrote:

> The *Engineering byDesign*™ Program has been developed through a series of carefully constructed processes that integrates the concepts of school reform and aligns with the goals of the NASDCTEC States' Career Clusters Initiative. In addition, as one of the only standards-based models available, the *EbD*™ Program is able to deliver content knowledge and skills for both the STEM and IT Clusters through themes that closely align with their identified Career Cluster Knowledge & Skills (p. 7).

ITEA-CATTS *EbD*™ courses were created with three standards-based documents as the core: *STL*; *the Principles and Standards for School Mathematics;* and *Project 2061, Benchmarks for Science Literacy*. The *EbD*™ program courses (see Appendix A) brought forth student technological awareness and competence as it built upon learned knowledge and skills (*EbD*™, 2007; ITEA, 2003). The *EbD*™ courses were designed to integrate with each other so that content complexity increased when students encountered it in higher grades. Moreover, *EbD*™ courses contained connections to pre-engineering content that created interest toward integrated curriculum development efforts (LaPorte & Sanders, 2008; NAE, 2000; NRC, 2002).

The *Engineering byDesign*™ (*EbD*™) model curricula comprised standards-based courses for each K-12 grade level. For the elementary grades, *Integrated Concepts and Lessons* were developed to introduce basic technology concepts to all students in grade bands K-2 and 3-5. For the 6-8 grade level middle school students, three 18-week curricula programs were developed; these included *Exploring Technology*, *Invention and Innovation*, and *Technological Systems*. With grades 9-12, there were seven 36-week courses developed that were "all founded on national technology, science, and mathematics standards" to increase academic rigor at the K-12 level (McAlister, Hacker, & Tiala, 2008, p. 89).

At the high school level, the *EbD*™ (2007) program curricula provided students with an understanding of technological concepts infused with engineering content using the following course curricula: *Foundations of Technology*, *Technological Issues and Impacts*, *Technological Design*, and *Engineering Design*. Research revealed that the ITEA-CATTS curricular offerings could be implemented as units, individual courses, or in their entirety as an integrated, standards-based program (Burke, 2005).

Research has shown that ITEA-CATTS courses have provided for the application of engineering related content as cited within the *Standards for Technological Literacy* (Burke, 2006). ITEA (2007) asserted that a crucial factor of *EbD*™ was that students could become "knowledgeable about technology, and use hands-on lessons to apply and transfer this knowledge to common problems" (p. 13).

Moye (2009) recently conducted a study of teacher satisfaction rates in the teaching of one high school *EbD*™ course, *Foundations of Technology.* The findings indicated that teachers who taught the course not only had a high rate of satisfaction, but also were supportive of the curriculum. In 2006, Reeve promoted *Invention and Innovation* as a middle school *EbD*™ course that placed an emphasis on ease of understanding for implementation within an existing technology education program.

The importance of empirical studies in this literature review have suggested that ITEA-CATTS *EbD*™ curriculum can fit within current structures and should be well received by technology educators and administrators as a viable program that can teach technological literacy using the *Standards for Technological Literacy* (2007) as its content base. Given the current political landscape, Shown (2008) contended that supervision in technology education was important to understand the practical applications of curricula.

Supervision in Technology Education

The International Technology Education Association (ITEA) created the *Standards for Technological Literacy* (2007) to identify the content standards needed for advancement of the study of technology. To aid in that endeavor, *Advancing Excellence in Technological Literacy* (2003) was developed to provide the criteria and guidance for those charged with the responsibility of curriculum implementation. Both of these documents comprised the technological literacy standards that could help local supervisors to be effective (Ritz, Dugger, & Israel, 2002). The next section aims to help the reader understand local supervisor duties and responsibilities.

Role of the Technology Education Supervisor

Arguably, many of the important administrative tasks performed by local supervisors have not changed over the years since industrial arts transitioned to technology education. An unpublished research study by Jubilee (1979), *A study of the duties and responsibilities of the industrial arts supervisors in the Commonwealth of Virginia*, defined the positions of industrial arts supervisors in the Commonwealth of Virginia. Major findings of the 1979 research concluded that most efforts were spent on raising awareness, purchasing supplies and equipment, and "campaigning competency-based instruction for their respective school districts" (p. 37).

Despite major changes since that time, which have included new dimensions in technology (Gilberti & Martin, 2002), local supervisors still have accepted the goals of supervision as improvement of the total teaching-learning process (Shown, 2008). Supervisory personnel today performed many of the actions that were performed in 1979. According to Virginia's state supervisor, local supervisor responsibilities include curriculum and equipment decisions, safety, familiarity with all teachers and their efforts to increase student learning, keeping up with trends, and lots of paper work (L. Basham, personal communication, April 23, 2009).

A review of Virginia Department of Education (2007) literature indicated that the role of outstanding local supervisors included but were not limited to the following:

- To present appropriate in-service opportunities for teachers at various levels.
- To take part in conferences at international, state, regional, and local levels.
- To assist colleges and universities in developing technology education programs.

- To provide leadership in obtaining financial assistance to meet technology education program requirements.
- To promote technology education through community and state agencies.

Curriculum Change and Implementation Strategy

How do local supervisors affect the process of curriculum change? A review of an advisory committee handbook (VDOE, 2007) for career and technical education (CTE) local administrators revealed that, in addition to planning and coordinating for improvement, outstanding supervisors had the following responsibilities:

- To contribute to the development of technology education programs.
- To develop technology curriculum recognized for excellence.
- To assist in the preparation of ITEA-Council for Supervisors monographs, newsletters, and curriculum materials.
- To contribute to state publications, guides, and newsletters.

Bybee (2002) suggested that state and district supervisors "assume a major responsibility for implementation" (p. 8). Many decisions made by state and district level supervisors take into consideration other factors affecting curriculum development, such as funding, efficacy of programs, and available resources (Stone, Kowske, & Alfred, 2004). In addition, successful strategies also include marketing and awareness, which highlight a critical impact and connectedness to larger programs. Research has suggested that when states start small, stay focused on current availabilities, and incorporate lesson learned, they might develop their own paths toward success (NASDCTEC, 2007).

According to the NRC (2002), state and district policy decisions were influential factors to be considered when exploring the implementation of curriculum. As Reed

(2007) noted, "strong support for *STL* from the NAE and NRC highlight the influence of contextual forces" (p. 16). In addition, the state competencies (VDOE, n.d.) may create strict guidelines for curriculum development and implementation. Moreover, concerted efforts to move toward adoption of ITEA-CATTS courses by the *EbD*™ network of consortium states required district support from local supervisors.

From the perspective of a technology supervisor, Shown (2008) suggested "inclusion of pre-engineering programs…would enhance and strengthen" (p. 224) state programs but should not displace existing programs. These benefits must be coupled with teacher support. Another supervisor asserted, "The key to success in this process is to focus on ownership of the transition with the teachers" (M. Strinden, personal communication, April 27, 2009).

In 2007, the National Association of State Directors of Career Technical Education Consortium (NASDCTEC) conducted a quick response survey of state career technical education directors to determine the status of implementation of programs of study developed within the Career Clusters' framework. Findings of the study revealed perceptions and actions of participating partners such as local business and industry leaders, instructors, and administrators were critical to successful implementation.

More importantly, the efforts of local supervisors have secured funding, generated community support, and provided in-service teacher training. In Ritz, Dugger, and Israel (2002), the researchers contended that the local supervisor's role at the state level had been important given the significant effort required to market curricula and raise awareness, which also included the authority of local supervisors to affect curriculum changes within the public school system.

Summary

While the content standards provided a vision of technological literacy for all students, ITEA-CATTS *Engineering byDesign*™ (*EbD*™) provided the means by which educators could achieve this goal. Over the past two decades, ITEA and its professional support agencies have developed the content standards and *EbD*™ curricula to establish the commitment and direction needed by all professional educators.

Leaders in the profession, which include local supervisors, have provided financial support, raised an awareness of available curriculum, and demonstrated district leadership regarding the development and practical application of curricula. The major trend to focus efforts on these influences became prevalent as the world advanced technologically. Many sources suggested *EbD*™ to be a national model program that could fit a basic model suitable for advancing the profession. ITEA suggested that *EbD*™ effectively addressed both content standards and integration of STEM concepts. However, in contrast to the curriculum title, ITEA-CATTS courses should not be viewed exclusively as an engineering program. In fact, research revealed *EbD*™ to be several technological literacy courses created under a heading called *Engineering byDesign*™.

As a program curriculum, *EbD*™ was developed to teach technological literacy. Nevertheless, one might question grade level benefits or course alignments to state competencies. Most important, what do local supervisors believe about the reinforcement of core academic standards. In order to determine local supervisor awareness of these concerns, data needed to be collected. In the next section, the methods and procedures of the data collection process will be discussed.

CHAPTER III

METHODS AND PROCEDURES

The major purpose of this research was to become aware of Virginia local supervisor’s intent towards *Engineering byDesign*™ (*EbD*™) implementation and to describe their opinions about choosing courses to integrate into their existing local programs. This chapter described the methods and procedures used to gather information needed to conduct this study. Details of the population under study were identified and then instrumentation used to acquire data was discussed. In addition, this chapter provided an explanation of data collection procedures, along with a brief description of the statistical analysis.

Population

The population for this study consisted of 20 technology education supervisors within respective Virginia public school districts. The perceptions of these respondents were analyzed to determine their intentions toward implementation of *Engineering byDesign*™ (*EbD*™) curricula in their school systems.

The public school districts that composed the population were the following 20 cities and counties: Appomattox, Arlington, Chesapeake, Chesterfield, Danville, Fairfax, Frederick, Gloucester, Hampton, Henrico, King and Queen, Loudoun, Newport News, Norfolk, Poquoson, Prince William, Richmond, Smyth, Virginia Beach, and Wise. Local supervisors were identified from a Virginia Department of Education complete listing of technology education supervisors.

Instrument Design

The problem of the study was to determine the perceptions of Virginia technology education supervisors toward implementation of *Engineering byDesign*™ courses in Virginia public schools. To guide the researcher toward possible solutions to this problem, an *EbD*™ Questionnaire was developed to collect data from 20 local supervisors of technology education programs in their respective districts.

Survey Questions 1, 5, 6, and 10 used a five-point Likert scale that ranged from very low, low, moderate, high, to very high. Survey Questions 3, 7, and 9 sought information from the respondents in open-form, which included an area to provide further comment. Survey Questions 2, 4, 8, and 11 used a combination of forced choice responses to gather information. For each Likert-style response, numeric point values were assigned to each item (e.g., one point for very low to five points for very high). Similar open-form responses were summarized and clustered accordingly. Missing responses were assigned zero points and were included in a “Did not respond” category for statistical purposes (See Appendix C for a copy of the survey instrument).

Based upon research goals, five survey questions (1, 3, 4, 5, and 6) were specifically designed to measure respondent awareness of ITEA-CATTS *Engineering byDesign*™ course curriculum, which supported Research Question one. Three questions (2, 8, and 10) were designed to identify *EbD*™ courses that local supervisors would consider for implementation within five years, which supported Research Question 2. Three questions (7, 9, and 11) were developed to identify needs or required actions that local supervisors believed could have an effect on *EbD*™ curriculum implementation, and these supported Research Question 3.

The survey was pilot tested with the assistance of STEM Education faculty at Old Dominion University. These technology educators tested the questionnaire items for validity. Feedback helped to clarify items, improve organization, and see if the instrument would collect data sufficient for answering the research questions.

Methods of Data Collection

Survey research was conducted to examine the perceptions of technology education local supervisors toward implementation of *Engineering byDesign*™ courses. On June 15, 2009, the researcher sent the questionnaire with a cover letter (Appendix B), return envelope, and an *EbD*™ postcard to 20 local supervisors in Virginia school districts. The cover letter explained the importance and need for the study, guaranteed respondent confidentiality, and requested return of the completed questionnaire by direct mail. An *EbD*™ postcard provided a listing of the courses and an Internet link to the ITEA website where a more detailed description of the *EbD*™ curriculum could be found if desired (See Appendix D for a copy of the *Engineering byDesign*™ Postcard).

In addition, the cover letter notified respondents of their role in the research, that participation was voluntary, and that by returning the survey, they wished to participate. Respondents were given 10 days to complete and return the questionnaire. Data collection conflicts were resolved with follow-up methods that included the use of electronic mail and telephone methods to ensure the highest possible response rate.

Statistical Analysis

Upon return of the survey information, the researcher used descriptive statistical methods to organize, tabulate, and interpret the collected data. The data compiled from the returned questionnaires used number of responses, frequency of answers, and means to statistically analyze data. The frequency and number of responses were calculated and a percentage obtained to determine the courses planned for implementation within five years.

Summary

Chapter III content discussed the population, instrument design, methods of data collection, and statistical analysis procedures used in this study. Research has shown that practical application of new technology education curricula has needed support from many levels. Given Virginia's status as an *EbD*™ consortium state, the rationale for this study was to determine if local Virginia school systems planned to implement *EbD*™ courses into their program offerings.

Procedural methods for collecting data began by identifying the population of local supervisors from Virginia public school districts. Data collection efforts utilized survey methods. A questionnaire was developed with specific items that allowed local supervisor respondents in respective districts to reveal their perceptions toward implementation of *Engineering byDesign*™ courses. Descriptive statistical steps and techniques to analyze and interpret the research data were discussed.

The findings of the research were reported and presented in Chapter IV. While the chapter is comprised of subsections that discuss the response rate and report the survey responses, it should be noted that the survey questions were grouped in research question order, so major findings could be presented together. In addition, where open-form respondent answers were discussed, the statements were consolidated and clustered as a summary response followed by the corresponding number of responses for each.

CHAPTER IV

FINDINGS

This chapter presented an analysis of the data collected from the *EbD*™ Questionnaire, a survey instrument specifically designed to measure respondent awareness of ITEA-CATTS *Engineering byDesign*™ courses and curriculum. Subsections were established by response rate and survey questions in Research Question order. Tables were used to support the questionnaire data narrative. The problem of the study was to determine the perceptions of Virginia technology education supervisors toward implementation of *Engineering byDesign*™ courses in Virginia public schools.

Response Rate

EbD™ Questionnaires were sent out to 20 respondents using direct mail methods on June 15, 2009. Based on low initial response rates, follow-up methods using the telephone and email were needed to increase response rates. The data collection period spanned 30 days from June 15 to July 15. Ninety-five percent of the population, or 19 out of 20 local supervisors, participated in the survey research via direct mail, electronic email, or telephone methods. The researcher received seven questionnaires from direct mail methods, eight by telephone, and four via email. All data collection methods have been consolidated as a total response rate percentage. Despite follow-up methods, one questionnaire was not received by the July 15 deadline. Table 1 shows the response rate.

Table 1

Response Rate

Number Sent	Number Collected	Total Response Rate
20	19	95 %

Report of Survey Findings

The findings from the questionnaire items were reported with respect to applicable research questions. A narrative description for each aggregated and tabulated questionnaire item response was provided with a corresponding table. Due to the 95 percent response rate, data analysis figures were deemed sufficient to represent a larger population of local supervisors. Despite the occasional non-response, none of the data items presented for analysis had an aggregate response rate below 84 percent. The researcher used descriptive statistical methods to organize and tabulate collected data. The data compiled from the returned questionnaires used number of responses, frequency of answers, and mean to statistically analyze and to aggregate data.

Engineering byDesign*™ *Awareness

Research Question 1 was *How aware are Virginia technology education supervisors of the ITEA-CATTS Engineering byDesign*™ *courses and their curriculum?* To answer this question, five survey questions (1, 3, 4, 5, and 6) were designed to measure respondent awareness of ITEA-CATTS *Engineering byDesign*™ course curriculum. Likert scale values assigned to each response ranged from zero points for “Did not respond” to five points for “Very high” and used for calculation of the mean.

In Question 1, respondents were asked to rate their awareness of *Engineering byDesign*™ *(EbD*™*)* program curricula for teaching technological literacy. The mean response for local supervisor awareness *of EbD*™ program curricula for teaching technological literacy was calculated as 3.0, which indicated that a majority (42%) perceived their awareness of *EbD*™ to be moderate. While 32 percent (n = 6) rated themselves in categories above the mean, approximately 26 percent of the respondents rated their awareness level below the mean. The Likert scale frequency of responses and percentage of answers for Question 1 were presented in Table 2.

Table 2

EbD™ Awareness Rating

	Did not respond *f* (%)	Very Low *f* (%)	Low *f* (%)	Moderate *f* (%)	High *f* (%)	Very high *f* (%)	*M*
Q #1	0 (0.00)	2 (10.53)	3 (15.79)	8 (42.11)	5 (26.32)	1 (5.26)	3.0

Note. *f* = frequency of response; % = percentage (rounded two decimal values); total number of respondents, n = 19; *M* = mean (rounded one decimal value); mode = 8

In Question 3, respondents were asked for their professional opinion regarding the completeness of *EbD*™ courses for studying technological literacy at the middle/high school level. Respondents could provide more than one comment, which were varied. Similarities in respondent answers were summarized and clustered accordingly with regard to respondent rating of course completeness.

Twelve of 19 respondents (63%) provided comments that were supportive of the *EbD*™ courses and curriculum. For example, they responded that the *EbD*™ curriculum was "very complete and in synch with technology standards." Among those 12 respondents who were supportive of the *EbD*™ curriculum, 26 percent (n = 5) cited content standards (STL), exceptional planning, and technological literacy as the primary reasons for their completeness rating. In addition, 16 percent (n = 3) responded that the curricula was complete, having justified their responses with examples such as comprehensiveness of curricula, available resource activities, and potential student experiences as the main source for their perception rating scores. One respondent commented, “The lessons and activities that support the *EbD*™ curriculum give the students the knowledge needed to be successful in today’s society.”

In contrast, not all local supervisors were supportive of *EbD*™ courses or curriculum. Five of the respondents (26%) did not believe the curriculum was complete, citing additional work that needed to be done. Moreover, four respondents (21%) stated their districts already used *Project Lead the Way*™ curriculum, and therefore were not considering *EbD*™ course implementation. Three local supervisors (16%), who did not respond to this question, commented that they were unfamiliar with the *EbD*™ curricula. One respondent commented that although the *EbD*™ courses “mirror our state competencies; I don’t see any more details.” The responses to Question 3 were presented as clustered summaries of selected respondent comments in Table 3.

Table 3

Open-Form Responses Regarding Completeness

Q# 3 Clustered Responses
• Models national standards to raise technological literacy. (n = 5)
• Must be tailored to meet our needs with existing courses. (n = 4)
• Well thought out, planned, and developed. (n = 3)
• Impressed by the activities. (n = 2)
• Best implemented in the middle school. (n = 2)
• Good match to state competencies. (n = 2)
• Wide variety of teacher resources. (n = 2)
• Consistency in method and approach. (n = 2)
• High school courses need some work. (n = 2)
• Did not respond. (n = 3)

Note. Local supervisor respondents, n = 16

In Question 4, respondents were asked to select the response that most accurately described their understanding of *EbD*™ program curriculum. Data indicated that nearly 95 percent (n = 18) of the respondents were aware of *EbD*™ courses. However, one local supervisor was unfamiliar with the courses and therefore did not respond. Among the varying awareness levels reported, data showed that a 58 percent majority (n = 11) of those who responded did not favor implementation, had not reviewed the courses, or were not considering implementation. To the contrary, almost 37 percent (n = 7) favored implementation, which was the largest single percentage among participating respondents. The data reported in Table 4 shows the related percentages of item selections and the frequency of responses for Question 4.

Table 4

Local Supervisor Understanding of EbD™

Q# 4 Stem	x	f	f_c	%	$\%_c$
Did not respond *(Not aware of EbD™ courses or curricula)*	6	1	19	5.56	100.00
I am aware of the *EbD*™ courses and do not favor implementation.	5	3	18	15.79	94.74
I am aware of the *EbD*™ courses, but have not specifically reviewed them.	4	5	15	26.32	78.95
I have viewed the *EbD*™ curricula, but have not considered implementation.	3	3	10	15.79	52.63
I have considered selective course implementation of *EbD*™ curricula.	2	7	7	36.84	36.84
I am considering full implementation of most or all *EbD*™ program curricula.	1	0	0	0	0

Note. x = ordinal ranking; f = frequency; f_c = cumulative frequency; % = percentage (rounded two decimal values); $\%_c$ = cumulative percentage; arithmetic mean = 2.63; mode = 7

In Question 5, respondents were asked to rate the curricular value of *EbD*™ courses to reinforce core academic standards at the middle/high school level. The mean response for local supervisor awareness was 3.7, which indicated that a majority (69%) perceived to a high degree that *EbD*™ courses reinforced core academic standards. Two respondents cited insufficient knowledge of *EbD*™ for not answering the question.

In Question 6, respondents were asked to rate *EbD*™ curricula as a standards-based model for implementing technological literacy/engineering design. The mean response for local supervisor awareness of *EbD*™ program curricula as a standards-based model was 3.1, which was moderate for this category. Eleven respondents (58%) were above the mean and rated this as high to very high. Four respondents (21%) either did not respond or rated very low, citing insufficient knowledge of *EbD*™. The Likert scale response frequencies and percentages for Questions 5 and 6 were presented in Table 5.

Table 5

Program Curricula Awareness Rating

	Did not respond *f* (%)	Very Low *f* (%)	Low *f* (%)	Moderate *f* (%)	High *f* (%)	Very high *f* (%)	*M*
Q #5	2 (10.53)	0 (0.00)	1 (5.26)	3 (15.79)	6 (31.58)	7 (36.84)	3.7
Q #6	3 (15.79)	1 (5.26)	0 (0.00)	4 (21.05)	9 (47.37)	2 (10.53)	3.1

Note. *f* = frequency of response; % = percentage (rounded two decimal values); total number of respondents, n = 19; *M* = mean (rounded one decimal value)

Engineering byDesign™ *Implementation Plans*

Research Question 2 was *Which ITEA-CATTS courses do local Virginia technology education supervisors believe could be implemented in their districts within the next five years?* To answer this question, three survey questions (2, 8, and 10) were designed to identify *EbD*™ courses that local supervisors would consider for implementation within five years. Each question was discussed individually.

In Question 2, respondents were asked to select the grade levels that they believed would receive the greatest benefit from *EbD*™ program curricula in their district. Respondents could provide more than one answer. Percentages were based on the number of times each item was selected by all respondents. The middle school grade band was selected just over 73 percent of the time (n = 16). The mean response for Question 2 was 3.18, which indicated that "Middle School (6-8)" was the more popular and most frequently reported choice by 19 respondents. The second most preferred choice among respondents was the high school grade band (9-12), which was selected near 53 percent of the time (n = 10) relative to available choices. The response frequencies and percentages for Question 2 were presented in Table 6.

Table 6

Implementation Choice(s) by Grade Band

Q# 2 Stem	x	f	f_c	%
High School (9-12)	4	10	28	52.63
Middle School (6-8)	3	14	18	73.68
Elementary School (3-5)	2	3	4	15.79
Elementary School (K-2)	1	1	1	5.26

Note. x = ordinal ranking; f = frequency; f_c = cumulative frequency; % = percentage (rounded two decimal values); total number of respondents, n = 19; arithmetic mean = 3.18; mode = 14

In Question 8, respondents were asked to select all *EbD*™ courses that they favored for implementation within five years in their district. Respondents could provide more than one answer. Percentages were based on the cumulative number of times each item was selected. The middle school level course selections were reported most frequently ($f_c = 45$) at a ratio of more than 2 to 1 when compared with elementary and high school *EbD*™ courses combined ($f_c = 20$). The most frequently selected course, *Invention and Innovation,* was reported 16 times (84%). Elementary K-2 and 3-5 grade band lessons were reported less often (5% and 21%, respectively). Two respondents commented that *Children's Engineering*™, which was not included in the study, was a course they were interested in implementing. Among high school courses, *Engineering Design* and *Foundations of Technology*, were selected 37 and 26 percent of the time, respectively, by local supervisors (n = 12). No respondent selected *Technological Issues and Impacts*. Cumulatively, 19 respondents made 65 choices among nine courses. The response frequencies and percentages for Question 8 were presented in Table 7.

Table 7

Implementation Choice(s) by Course

Q# 8 Stem	x	f	f_c	%
K-2 Integrated Concepts & Lessons	10	1	65	5.26
3-5 Integrated Concepts & Lessons/I^3	9	4	64	21.05
Exploring Technology	8	15	60	78.95
Invention and Innovation	7	16	45	84.21
Technological Systems	6	14	29	73.68
Foundations of Technology	5	5	15	26.32
Technological Issues and Impacts	4	0	10	0
Technological Design	3	3	10	15.79
Engineering Design	2	7	7	36.84
None *(Did not respond)*	1	1	0	5.26

Note. x = ordinal ranking; f = frequency; f_c = cumulative frequency; % = percentage (rounded two decimal values); total number of respondents, n = 18; arithmetic mean = 6.30; mode = 16

In Question 10, respondents were asked to rate the importance given toward the ease of understanding for teachers of *EbD*™ courses in their district. Likert scale values assigned to each response ranged from zero points for "Did not respond" to five points for "Very high." The mean (*M* = 4.0) for Question 10 indicated that respondents placed ease of understanding in the category that was highly important. Respondents believed that *EbD*™ curriculum should be easy for teachers to understand, irrespective of awareness levels, as a positive factor to aid implementation.

While 42 percent of the respondents (n = 8) rated this importance very high; likewise, nearly 32 percent (n = 6) rated this at a high importance. One respondent commented, "If it is hard to understand, then it will be harder to implement." Almost 16 percent (n = 3) of the respondents rated the ease of understanding as moderate. Data indicated that 21 percent of those who would consider implementation also believed that ease of implementation was important. One supervisor, who rated ease of understanding high, commented that "as a well-designed" program, *EbD*™ was "setup for educators to understand." All respondents participated in answering this question. The Likert scale response frequencies and related percentages for Question 10 were presented in Table 8.

Table 8

Implementation Rating by Ease of Understanding

	Did not respond *f (%)*	Very Low *f (%)*	Low *f (%)*	Moderate *f (%)*	High *f (%)*	Very high *f (%)*	*M*
Q #10	0 (0.00)	1 (5.26)	1 (5.26)	3 (15.79)	6 (31.58)	8 (42.11)	4.0

Note. *f* = frequency; % = percentage (rounded to two decimal values); *M* = mean; total number of responses, n = 19

Strategies for Implementation

Research Question 3 was *What needs to occur for Virginia school systems to implement the Engineering byDesign*™ *courses?* To answer this question, three survey questions (7, 9, and 11) were developed to determine plans that must be developed to enable implementation of *EbD*™ courses. Collectively, these questions were designed to identify needs, or required actions, that local supervisors believed could affect strategy development. Each question was discussed individually.

In Question 7, respondents were asked to describe the processes that govern implementation of *EbD*™ curriculum within their district. Respondents could provide more than one comment, which were varied. Similarities in respondent answers were summarized and clustered accordingly. It was discovered that each school district had varying degrees of implementation governance; that is, different cities and counties had different curriculum policies. On the one hand, data showed that 58 percent (n = 11) of local supervisors had the authority to implement curriculum at their level, subsequently initiating the implementation process. Nearly half (21%) of those eleven respondents stated that "persuasion" was the key element toward final approval by the school principal.

On the other hand, according to seven of 19 local supervisors (37%), curriculum review committees, teams, and (CTE advisory) councils govern the initial stages of implementation. These supervisors reported that the major action needed to initiate the process included presenting "agenda items" through official channels using committee or council meeting protocols. Subsequent administrative approval was followed by school board approval, which was the final governing stage.

In addition, local supervisors reported process paperwork for funding resources included submitting approval to the state in accordance with the Perkins Act. In all cases (n = 18), needs assessments and financial considerations associated with material supplies and equipment costs influenced the decision-making process. The consolidated and clustered summaries of respondent comments for Question 7 were presented in Table 9.

Table 9

Open-Form Responses Regarding Implementation Governance

Q# 7 Clustered Responses
• Local supervisor initiates the process by recommending to superintendant/director level for approval followed by presentation to school board for approval. (n = 5)
• Group (advisory council/committee/team) initiates the process with final approval authority to implement. (n = 4)
• Local supervisor initiates the process, followed by school principal approval prior to implementation. (n = 3)
• Local supervisor initiates and completes the implementation process. (n = 3)
• Group (advisory council/committee/team) initiates the process with official (written) recommendation to school board for approval. (n = 3)
• Did not respond. (n = 1)

Note. Local supervisor respondents, n = 18

In Question 9, respondents were asked to identify three or four major actions or activities that must occur to implement or enable *EbD*™ courses within their district. Respondents could provide more than one comment, which resulted in varied responses. Similarities in respondent answers were summarized and clustered accordingly. The most frequently reported major actions, according to 57 percent (n = 11) of the local supervisors, were staff development, teacher awareness, and in-service training. Among

47 percent of the respondents (n = 9), the second most frequently reported activity involved methodology to solve budgetary issues for teacher enhancements and materials.

Furthermore, 16 percent of the respondents (n = 3) believed that marketing efforts by the state supervisor, student enrollment, and "interactivity with *Project Lead the Way*™" were activities that, if increased, would enable *EbD*™ course implementation to occur within their district. One local supervisor noted that while STEM integration may have a favorable influence, "technological literacy knowledge does not carry the same weight with those outside the field of technology education."

Yet, three others (16%) reported that STEM integration was needed to enable *EbD*™ implementation in their respective districts. Two supervisors (10%) reported that once curriculum was approved, a single site course pilot with an assessment of results needed to occur prior to district-wide consideration, scheduling, and implementation strategy development. Question 9 clustered responses were presented in Table 10.

Table 10

Open-Form Responses Regarding Implementation Actions

Q# 9 Clustered Responses
• Staff development, teacher awareness, and in-service training. (n = 11)
• Cost budgeting for teacher endorsement, materials, and equipment. (n = 9)
• Alignment with Virginia Standards of Learning and student competencies. (n = 4)
• Curriculum review, course pilot requirements, and results assessment. (n = 3)
• Student enrollment versus teacher allocation and needs justification. (n = 3)
• Increased marketing efforts by state supervisor. (n = 3)
• STEM integration and interactivity with *Project Lead the Way*™. (n = 3)
• Answers that duplicated Question 7 responses *(not useable)*. (n = 2)

Note. Local supervisor respondents, n = 16

In Question 11, respondents were asked to project an implementation timeline for *EbD*™ courses within their district. These agenda projections assumed that decisions were based on completion of the curriculum approval process. Thirty-two percent of the population (n = 6) reported that three to five years were needed to implement *EbD*™ curriculum within their district. While 21 percent of the population (n = 4) projected *EbD*™ curriculum implementation may occur within two years, two respondents (11%) reported that implementation was in progress at the middle school level.

Conversely, three respondents (16%) stated that implementation plans would occur in more than five years. One supervisor commented, "Too many courses exist at the state level," whereas another reported that *EbD*™ was "not a mandate for the state approved courses." Four respondents, or 21 percent of the population, did not respond for reasons stated as economic uncertainty, district administration reluctance, and "just not considering it." Table 11 shows the response frequencies and related percentages for Question 11.

Table 11

Perception of Implementation Agenda

Q# 11 Stem	x	f	f_c	%	$\%_c$
Did not respond	6	4	19	21.05	100.00
More than five years	5	3	15	15.79	78.95
Three to five years	4	6	12	31.58	63.16
Within 2 years	3	4	6	21.05	31.58
Six months or less	2	0	2	0	10.53
Currently in progress	1	2	2	10.53	10.53

Note. x = ordinal ranking; f = frequency; f_c = cumulative frequency; % = percentage; $\%_c$ = cumulative percentage (all percentages rounded two decimal values)

Summary

In this chapter, the researcher reported the aggregate findings regarding the perceptions of 19 local supervisors of technology education programs in Virginia. Subsections of Chapter IV included population response rates, as well as item response narratives and tabulated data, which categorized questions by Research Question order. The survey instrument data, which was collected via direct mail, telephone, and email methods, was interpreted and presented using descriptive statistics; that is, frequency of responses, percentages, and mean. The data were analyzed to determine respondent awareness of ITEA-CATTS *Engineering byDesign*™ course curriculum, and specifically, whether implementation of any *EbD*™ courses might occur within five years.

In Chapter V, *Summary, Conclusions, and Recommendations*, the researcher will present a synopsis of local supervisor's perceptions using the aggregate data findings. In addition, conclusions will be drawn based on reported data to answer the three research questions, which guided this study. This will be followed by a review of recommendations and proposals for future studies and research.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Many in the field of academia recognize the need to increase their awareness toward the efforts made by technology education professionals who incorporate technical, social, and cultural content into their curriculum. This study emerged from a need to understand what degree of importance local supervisors of technology education placed on *Engineering byDesign*™ (*EbD*™) courses as a means to produce technologically literate students. Furthermore, the motivation for this research sought to understand local supervisor interests and beliefs regarding district implementation of *EbD*™ courses and describe their opinions about choosing standards-based courses to integrate in their technology programs. The perceptions of these technology education supervisors were needed to determine if implementation of *EbD*™ courses in respective districts might occur within five years.

Summary

The problem of the study was to determine the perceptions of Virginia technology education supervisors toward implementation of *Engineering byDesign*™ courses in Virginia public schools. The following research questions established boundaries for this study and guided the researcher toward possible solutions to this problem.

- How aware are Virginia technology education supervisors of the ITEA-CATTS *Engineering byDesign*™ courses and their curriculum?
- Which ITEA-CATTS courses do local Virginia technology education supervisors believe could be implemented in their districts within the next five years?

- What needs to occur for Virginia school systems to implement the *Engineering byDesign*™ courses?

The major reason for conducting this study was that Virginia had not developed much curriculum for technology education in the past decade. Since the International Technology Education Association (ITEA) took action to develop curricula based on content standards for consortium states to use, the question of implementation remained unanswered. An important goal of the study was to become aware of Virginia local supervisor intent toward *EbD*™ implementation. To achieve this, the researcher collected data that described local supervisor's opinions and perceptions about choosing such courses to integrate in their local programs. In addition, this study discussed actions and activities that enabled teachers to implement these courses.

The findings of this research were limited by certain factors and conditions. In this study, the perceptions were acquired from and limited to local supervisors degreed in technology education in the Commonwealth of Virginia. The options for implementing standards-based curricula were limited to the ITEA-CATTS *Engineering byDesign*™ courses. Although the research study did not examine curriculum offerings available within each district, four local supervisors who commented on the questionnaire noted two curricula programs, *Children's Engineering*™ and *Project Lead the Way*™, were of interest to them. Data collection efforts consisted of communications with Virginia local supervisors in charge of technology education programs.

The population for this study consisted of 19 technology education supervisors within respective Virginia public school districts. The perceptions of these respondents were analyzed to determine their intentions toward implementation of *EbD*™ curricula in their school systems.

The researcher developed an 11-item questionnaire to collect data. This survey design allowed for respondents to reveal their awareness of and intentions toward *Engineering byDesign*™ course implementation. On June 15, 2009, the researcher sent a survey packet to each respondent, which contained one *EbD*™ Questionnaire, a personalized cover letter, *EbD*™ Postcard, and postage-paid return envelope. The accompanying cover letter explained their role in the research and that participation was voluntary. Data collection efforts concluded on July 15, 2009.

Once all questionnaire information had been acquired, the researcher used descriptive statistical methods to organize and tabulate collected data. The data compiled from the returned questionnaires was analyzed and interpreted in aggregate form using frequency of responses, percentage of answers, and mean.

Conclusions

This section answered each research question based of data collected and reported. Empirical evidence gained from this study may help to generalize research findings in support of data based decision-making, while expanding the limited body of empirical data and current knowledge. This survey research yielded mixed reviews regarding the awareness of *EbD*™ course curriculum and intentions toward implementation.

Research Question 1: *How aware are Virginia technology education supervisors of the ITEA-CATTS Engineering byDesign™ courses and their curriculum?* The researcher discovered that a majority of Virginia local supervisors indicated that their awareness was moderate to very low. In retrospect, based on the low awareness levels reported, difficulty was noted for those local supervisors who responded to survey questions (via telephone) that required a requisite knowledge of *EbD*™. In some cases, the supervisor ratings were not consistent among related questionnaire items. For example, despite low to moderate awareness rating responses on Question 1, respondents then rated the ability of *EbD*™ curriculum to reinforce core standards as a standards-based model high to very high in Questions 5 and 6, respectively. Nevertheless, most local supervisor respondents were aware that *EbD*™ curriculum existed and that it had potential benefits to teach technological concepts.

However, data did not show a high association with regard to teaching technological literacy. Given the limited awareness and authority to directly implement curriculum, coupled with administrative duties, supervisors reported being unable to deal with the real "issue of technological literacy." Therefore, based on interpretation of the data, it can be concluded that Virginia local supervisors were moderately aware of *EbD*™ courses and curriculum.

Research Question 2: *Which ITEA-CATTS courses do local Virginia technology education supervisors believe could be implemented in their districts within the next five years?* The researcher discovered local supervisor responses most frequently reported were the middle school grade level courses (*Exploring Technology, Invention and Innovation, and Technological Systems*) and one high school course (*Foundations of Technology*). These four fit the category of courses most favored and selected for implementation within five years. Another finding revealed other Virginia courses, which currently exist, that bear similar names albeit different in content. This familiar association may have led to the high selection of those particular *EbD*™ courses by local supervisors whose awareness of *EbD*™ program curricula was low. Moreover, it could be perceived that similarly titled courses were familiar and therefore easier to implement. Data collection efforts indicated only a partial answer as to whether local supervisors could describe content level differences between exiting courses and *EbD*™ curricula.

Although a small percentage of respondents (21%) believed that grade band 3-5, *Integrated Concepts and Lessons*, could be integrated into exiting classrooms easily, nearly three out of every 4 local supervisors, or 74 percent, perceived that Middle School (6-8) programs would have the greatest impact and benefit for their district. Local supervisor response data revealed a perception that when a large number of courses exist in technology education at the state level, the likelihood of district level success for adding more courses (e.g., *EbD*™) without subsequent deletions was reduced.

No respondent indicated to the researcher that they were considering full implementation of all *EbD*™ program curricula. Although data revealed mixed interest in EbD™ courses, it can be concluded that the intentions of local supervisors were to selectively choose components of *EbD*™ for implementation within their district. Therefore, based on interpretation of the data reported, three middle school courses and one high school course could be implemented within five years.

Research Question 3, *What needs to occur for Virginia school systems to implement the Engineering byDesign™ courses,* revealed that widely varying processes govern implementation of curriculum. While district size did not indicate a preference toward a particular governing process, data revealed that significant factors for determining what needed to be done; that is, it pointed to a call for promotional awareness. This became evident when the data showed that local supervisors were more familiar with *Project Lead the Way*™ than they were with *EbD*™.

More important, administrative acceptance was another issue raised by local supervisors, which was both critical and prevalent in every district surveyed. Data revealed that key elements of implementation were, to a large degree, administrative buy-in and funding, which included miscellaneous costs associated with classroom materials and equipment. Surprisingly, findings showed that benefits of technological literacy were not the primary motivator for consideration of *EbD*™ curricula among a 58 percent majority of local supervisors. Although an *EbD*™ information postcard was provided for the respondents to help themselves become familiar with the courses and curriculum, it could not be determined whether local supervisors understood that *EbD*™ curriculum was free and readily available from the ITEA-CATTS webpage (*username and passwords provided by VA state supervisor*).

Teacher training issues were reported to be a justifiable concern that needed to be addressed prior to implementing *EbD*™ courses. Only two of 19 local supervisors, or 11 percent, made the researcher aware of their exposure to *EbD*™ through training provided by ITEA-CATTS. However, the overarching problem reported by nearly one in four local supervisors (21%) was a requirement to ensure that new courses were in alignment with state competencies. An important connection to be made with regard to implementation was that better support and acceptance could be realized with an increase in marketing efforts and course alignments with district curricular policies.

Interestingly, the STEM integration approach was a popular topic among 10 to 20 percent of the local supervisors. However, data indicated that this integration was exclusively associated with the *Project Lead the Way*™ program. The researcher was made aware that, more often than not, STEM carried more weight than the benefit of technological literacy. Moreover, irrespective of its ability to produce technologically literate students, for curriculum changes to occur, key people in positions of authority needed to be more than moderately aware of *EbD*™, and they needed to be able to argue its relevance in terms of the reinforcement to core academic standards and state competencies. Given these two examples, one might question whether *EbD*™ should include advertisement of STEM content integration as a major goal to increase awareness.

Clearly, collected data emphasized that most school curricula was determined in part by the Virginia *Standards of Learning* state requirements. This included the tendency to rely on course enrollment, which, if it were low, the forced removal of electives from course offerings would surely follow. While STEM integration was acknowledged by local supervisors to be a promising avenue with which to spark *EbD*™ curricula interest, they also asserted the need for empirical data to support such integration.

Consequently, based on interpretation of the data, the researcher determined through research that the following items needed to occur for Virginia public school systems to implement *EbD*™ courses and curriculum:

- Increase marketing efforts and techniques by the state supervisor,
- Increase teacher awareness through curriculum reviews,
- Establish a need for curriculum through state competency changes,
- Conduct alignment to state courses to increase support,
- Provide funding resources (Perkins) and budgeting leeway,

- Provide staff development and key teacher in-service training,
- Conduct course piloting and evaluation (as necessary), and
- Develop scheduling and implementation strategies (per district).

Given the perceptions of Virginia technology education supervisors toward implementation of *Engineering byDesign*™ courses in Virginia public schools, research concluded that a majority of local supervisors agree that *EbD*™ could effectively address both content standards and integration of STEM concepts. This study revealed that certain *EbD*™ courses were favored more than others were for consideration and implementation into local program offerings among three grade levels. However, the results of this study have determined that only 37 percent of the Virginia technology education supervisors would choose to implement ITEA-CATTS *Engineering byDesign*™ courses within five years. Specifically, the researcher found that one district had commenced *EbD*™ implementation in their middle schools, whereas another had begun tailored implementation of *EbD*™ with *Project Lead the Way*™ curricula at the middle school level. Overall, the study collected quality data to answer each of three research questions sufficiently; nonetheless, further research is needed, which will be discussed in the next section.

Recommendations

The findings of this study suggest a number of future directions for research aimed at understanding the relation between technological literacy standards, local district curriculum needs, and state competencies. In particular, future research is needed to examine marketing efforts at the state level that could increase *EbD*™ curricula awareness toward implementation. In addition, research should aim to create and develop a greater need for these specific courses. From start to finish, time is needed not only to develop awareness, but also to get administrative support and training programs in place.

Another suggestion for future research recommended by the researcher includes conducting an expanded study to cover all 149 public school districts in the Commonwealth of Virginia. A population that includes all district curriculum specialists, regardless of their knowledge of technology education, may accelerate the awareness of *EbD*™ courses and curriculum implementation across the state. This awareness could advance knowledge and might result in the expeditious implementation of *EbD*™ once discovering that courses were available at no cost to the public school system.

In addition, while leadership has provided for the improvement of education, it needs to be realized that *EbD*™ courses can effectively address both content standards with an integration of STEM concepts. Several factors were identified that had an adverse affect on the success of *EbD*™ curriculum implementation. For instance, technological literacy knowledge does not carry the same weight with those outside the field of technology education. STEM integration was noted as a hot button topic that could positively influence approval of *EbD*™ courses and curriculum. Furthermore, local supervisors had multiple job responsibilities that were reported to prevent focusing solely on technology education.

However difficult it may be for local supervisors and advisory councils to “sell technological literacy” to local school boards, more local supervisors should consider implementation of this standards-based curriculum using STEM integration as justification. The researcher recommends that local supervisors selectively implement the courses that were favored, which could reveal new perceptions of *EbD*™ curricula. This in turn could create new opportunities for data collection efforts designed to explore content level differences between exiting courses and *EbD*™. Notably, future research to study dissimilarity would benefit technology programs in terms of alignment with state career and technical education competencies, which, in this study, appeared to be a significant barrier toward implementation of *EbD*™ curricula in Virginia public school districts.

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APPENDICES

Appendix A: *Engineering byDesign*™ Course Descriptions

Appendix B: Accompanying Cover Letter to Supervisor

Appendix C: Survey Instrument (*EbD*™ Questionnaire)

Appendix D: *Engineering byDesign*™ Postcard

APPENDIX A

Engineering byDesign™ Course Descriptions

Engineering byDesign™ Course Descriptions

This appendix is an adaptation of the *Engineering byDesign*™ (*EbD*™) promotional material documentation. (Source: http://www.iteaconnect.org/EbD/CATTS/cattspublicationsseries.htm.) It was intended to be a reference for review by local supervisors of technology education while completing the *EbD*™ questionnaire. However, it also serves as a source for the reader to become familiar with *EbD*™ content knowledge. Figure 1 illustrates the *EbD*™ courses contained within the standards-based program. A brief description of the *Standards-Based Technological Study Series* (ITEA, 2004) has been provided for the elementary, middle, and high school courses.

Engineering byDesign™

Standards-Based Model – Grades K-12

K-2	1	Integrated concepts & lessons	
3-5	2	Integrated concepts & lessons *	
6	MS-1	Exploring Technology	18 weeks
7	MS-2	Invention and Innovation	18 weeks
8	MS-3	Technological Systems	18 weeks
9	HS-1	Foundations of Technology	36 weeks
10-12	HS-2/3	Technological Issues and Impacts	36 weeks
10-12	HS-4	Technological Design	36 weeks
11-12	HS-5	Advanced Design Applications *	36 weeks
11-12	HS-6	Advanced Technological Applications *	36 weeks
11-12	HS-7	Engineering Design (Capstone)	36 weeks
13-16	CL	Engineering Design	Semester

* ProBase and I³ – NSF funded projects

ITEA

Figure 1. EbD™: Standards-Based Program Series

Elementary School Level Resources

Technology Starters: A Standards-Based Guide

This guide provides standards-based content, activities, and resources for introducing technology content in selected units of instruction. The information contained in this guide will assist teachers in beginning to implement *STL*. In addition, state, provincial, and local curriculum developers can use this guide to create standards-based curriculum to increase technological literacy. It highlights technology as a core and thematic subject in diverse school environments. Sample handouts, illustrated examples, and classroom photographs provide clear guidance for implementation.

Models for Introducing Technology: A Standards-Based Guide

This standards-based resource provides strategic directions for developing contemporary, standards-based beginning level units and thematic instruction compatible with *Standards for Technological Literacy: Content for the Study of Technology* (ITEA, 2007). Content will include curriculum goals and objectives, instructional strategies and sequences, content connections, and sample student assessment strategies.

Middle School Level Resources

Exploring Technology: A Standards-Based Middle School Model Course Guide

This guide provides a standards-based model for a problems-based middle school course. It includes standards/benchmarks that are being taught, guiding principles, big Ideas/concepts, units with lessons that include hands-on problems, and assessments at the course, unit, and lesson levels. Mathematics and science concepts are integrated into all content, lessons, and rubrics. *Exploring Technology* helps students to develop an understanding of the scope of technology through hands-on experiences. This will help students experience and understand ways in which technological knowledge, abilities, and skills contribute to the effective design and solutions to technological problems.

This course curriculum also provides students in Grade 6 with opportunities to apply the design process in the invention or innovation of a new product, process, or system. Students participate in activities to understand how criteria, constraints, and processes affect designs. They learn about brainstorming, visualizing, modeling, constructing, testing, experimenting, and refining designs. Students also develop skills in researching information, communicating design information, and reporting results.

Invention and Innovation: A Standards-Based Middle-School Model Course Guide

This guide provides a standards-based model for a problems-based middle school course. It includes standards/benchmarks that are being taught, guiding principles, big Ideas/concepts, units with lessons that include hands-on problems, and assessments at the course, unit, and lesson levels. Mathematics and science concepts are integrated into all content, lessons, and rubrics. *Invention and Innovation* (Grade 7) helps students to develop an understand design concepts used in invention and innovation through hands-on experiences. This will enable students to explore and understand ways in which technological knowledge, abilities, and skills are used to develop effective design and solutions to technological problems and improve these designs to create products that improve everyday life.

Technological Systems: A Standards-Based Middle School Model Course Guide

Technological Systems is intended to teach students in Grade 8 how technological systems work together to solve problems and capture opportunities. As technology becomes more integrated, and systems become more and more dependent upon each other than ever before, this course gives students a general background on the different types of systems, with particular concentration on the connections between these systems. It includes standards that are being addressed, interesting learning activities, and strategies for student assessment. Students work in teams to address systems design challenges.

High School Level Resources

Foundations of Technology: A Standards-Based High School Model Course Guide.

This guide provides strategic directions for developing a ninth grade high school cornerstone course compatible with *Standards for Technological Literacy: Content for the Study of Technology* (ITEA, 2007). Content includes curriculum goals and objectives, content connections, instructional strategies and sequences, and sample assessment strategies. Group and individual lessons engage students in creating ideas, developing innovations, and engineering practical solutions. Technology content, resources, and laboratory activities include mathematics and science concepts. These integrate into the lessons and rubrics and prepare students to understand and apply technological concepts.

Technological Issues and Impacts: A Standards-Based High School Model Course Guide.

This guide will provide a model for a problems-based high school course. It includes standards that are being addressed, guiding principles, big Ideas/concepts, lessons that include hands-on problems, and unit, lesson, and end-of-course rubrics. Students investigate critical historical and emerging issues affecting the creation, development, use, and control of technology. Student teams address complex issues and propose alternative solutions to technological developments. Global governmental, social, and economic policies concerning technology are also studied. Mathematics and science concepts are integrated into the content, lessons, and rubrics.

Impacts of Technology: A Standards-Based High School Model Course Guide

This guide provides suggestions for developing a challenging design-based high school course. It will include standards that are being addressed, challenging hands-on learning activities, and strategies for student assessment. Students will assess the effectiveness of new ideas, innovations, and technological systems through analysis and redesign.

Technological Design: A Standards-Based High School Model Course Guide

Engineering scope, content, and professional practices are presented through practical applications. Students in engineering teams apply technology, science, and mathematics concepts and skills to solve engineering design problems and create innovative designs. Students will research, develop, test, and analyze engineering designs using various criteria.

Engineering Design: A Standards-Based High School Model Course Guide.

This course is a highly rigorous, capstone experience for students who are interested in technology, innovation, design, and engineering. Students understand and apply knowledge and skills required to create and transform ideas and concepts into a product that satisfies specific customer requirements. Students will experience design engineering in the creation, synthesis, iteration, and presentation of design solutions and will coordinate and interact in authentic ways to produce the form, fit, and function documentation, with appropriate models to completely define a product.

Engineering scope, content, and professional practices are presented through practical applications. Mathematics and science concepts are integrated into all content, lessons, and rubrics. Students apply technology, science, and mathematics concepts and skills to solve engineering design problems and create innovative designs. Students research, develop, test, and analyze engineering designs using criteria such as design effectiveness, public safety, and ethics.

APPENDIX B

Accompanying Cover Letter to Supervisor

<<Date>>

<<Title>> <<Firstname>> <<Lastname>>
<<Address1>>
<<Address2>>
<<City>>, <<State>> <<Zip>>

<<Greeting Line>>

In 2008, Virginia regained participant status in the International Technology Education Association's Center to Advance the Teaching of Technology and Science consortium. This included access to *Engineering byDesign*™ curriculum as a benefit of membership. Although many technology programs have been created and implemented by innovative educators, we are interested to determine district supervisor intent toward *EbD*™ implementation. The purpose of our research study is to examine the perceptions of Virginia technology education supervisors regarding integration of *Engineering byDesign*™ courses into their local programs.

Enclosed you will find a questionnaire and an *Engineering byDesign*™ postcard, as well as a postage-paid return envelope. Participation in this study is voluntary. While you may choose not to respond, returning the survey indicates your desire to share knowledge and actively contribute to this research activity. Your assistance and expertise will add to the current body of research on technology education. In addition, the aggregate data will be useful in determining in-service plans that must be designed to enable teachers to implement *Engineering byDesign*™ courses. The information you provide will be safeguarded with confidentiality and reported only in aggregate form. Your completion and return of this survey indicates that you've been informed of the purpose of the study and your role, and that you consent to participate and allow us to use your responses in our study. Please accept our personal thank you for taking the time to answer and return the questionnaire.

Most important, your valuable time and efforts are appreciated. Completing the questionnaire should require about 10 minutes of your time. Please feel free to contact us should you have any questions or comments. All survey data will be held in strict confidence by the researchers. Please return the questionnaire in the postage-paid envelope by <<Date>>. Thank you in advance for your cooperation and support of this research study, as well as for your leadership to technology education in Virginia.

Sincerely,

Dr. John M. Ritz, DTE
Professor
Old Dominion University

Terrance M. Beddow
ODU Graduate Student
Email: TBedd001@odu.edu

Encl: Survey Instrument, *Engineering byDesign*™ postcard, Return Envelope

APPENDIX C

Survey Instrument (*EbD*™ Questionnaire)

OLD DOMINION UNIVERSITY

Engineering byDesign™

The purpose of this questionnaire is to gather feedback from district technology education supervisors regarding perceptions toward implementation of International Technology Education Association (ITEA) *Engineering byDesign™* courses in Virginia public schools. In cooperation with Old Dominion University, the researchers will hold all responses in strict confidence during this study. Information you provide will be statistically summarized with other responses by technology education supervisors and will not be attributable to any single individual. Participation is voluntary and the information you provide will be kept confidential.

Directions: Please darken the circle that indicates your selection or write-in your answer as appropriate. Each questionnaire item includes an area to provide further comment.

1. How would you rate your **awareness** of *Engineering byDesign™ (EbD™)* program curricula for teaching technological literacy?

○ Very low ○ Low ○ Moderate ○ High ○ Very high

Comment: ____

____

2. Which grade levels do you believe would receive the **greatest benefit** from *EbD™* program curricula within your district? (Select all that apply)

○ K-2 ○ 3-5 ○ 6-8 ○ 9-12

Comment: ____

____

3. What is your professional opinion regarding the **completeness** of *EbD™* courses for studying technological literacy at the middle/high school level?

Response: ____

____

____

____

4. Select the response that most accurately describes **your understanding** of *EbD*™ program courses and curriculum:

- ○ I am aware of the *EbD*™ courses, but have not specifically reviewed them.
- ○ I am aware of the *EbD*™ courses and do not favor implementation.
- ○ I have viewed the *EbD*™ curricula, but have not considered implementation.
- ○ I have considered selective course implementation of *EbD*™ curricula.
- ○ I am considering full implementation of most or all *EbD*™ program curricula.

Comment: ____

____

5. What is your professional opinion regarding the **reinforcement of core academic standards** by *EbD*™ courses at the middle/high school level?

○ Very low ○ Low ○ Moderate ○ High ○ Very high

Comment: ____

____

____

6. How would you rate *EbD*™ as a **standards-based model** curriculum for implementing technological literacy/engineering design?

○ Very low ○ Low ○ Moderate ○ High ○ Very high

Comment: ____

____

7. What processes **govern implementation** of *EbD*™ curriculum within your district?

Response: ____

____

____

____

____

____

8. Which of the following *EbD*™ courses do you believe would be **most favorable toward implementation** within five years in your district? (Please select all that apply)

Elementary School level

- ○ K-2 Integrated Concepts & Lessons
- ○ 3-5 Integrated Concepts & Lessons/I^3
- ○ None

Middle School level (6-8)

- ○ Exploring Technology
- ○ Invention and Innovation
- ○ Technological Systems
- ○ None

High School level (9-12)

- ○ Foundations of Technology
- ○ Technological Issues and Impacts
- ○ Technological Design
- ○ Engineering Design
- ○ None

Comment: ____

____

9. Please identify 3 or 4 major actions or activities that must occur to **implement or enable** *EbD*™ courses within your district?

Response: ____

____

____

____

____

____

____

____

10. How would you rate the importance given to **ease of understanding** for teachers of *EbD*™ courses within your district?

○ Very low ○ Low ○ Moderate ○ High ○ Very high

Comment: ____

____

____

11. When do you **plan to implement** *EbD*™ courses within your district?

- ○ Currently in progress
- ○ Six months or less
- ○ Within two years
- ○ Three to five years
- ○ More than five years

Comment: ____

____

____

Additional Comments: (Please indicate if you would like to receive a copy of the completed survey research via email)

____

____

____

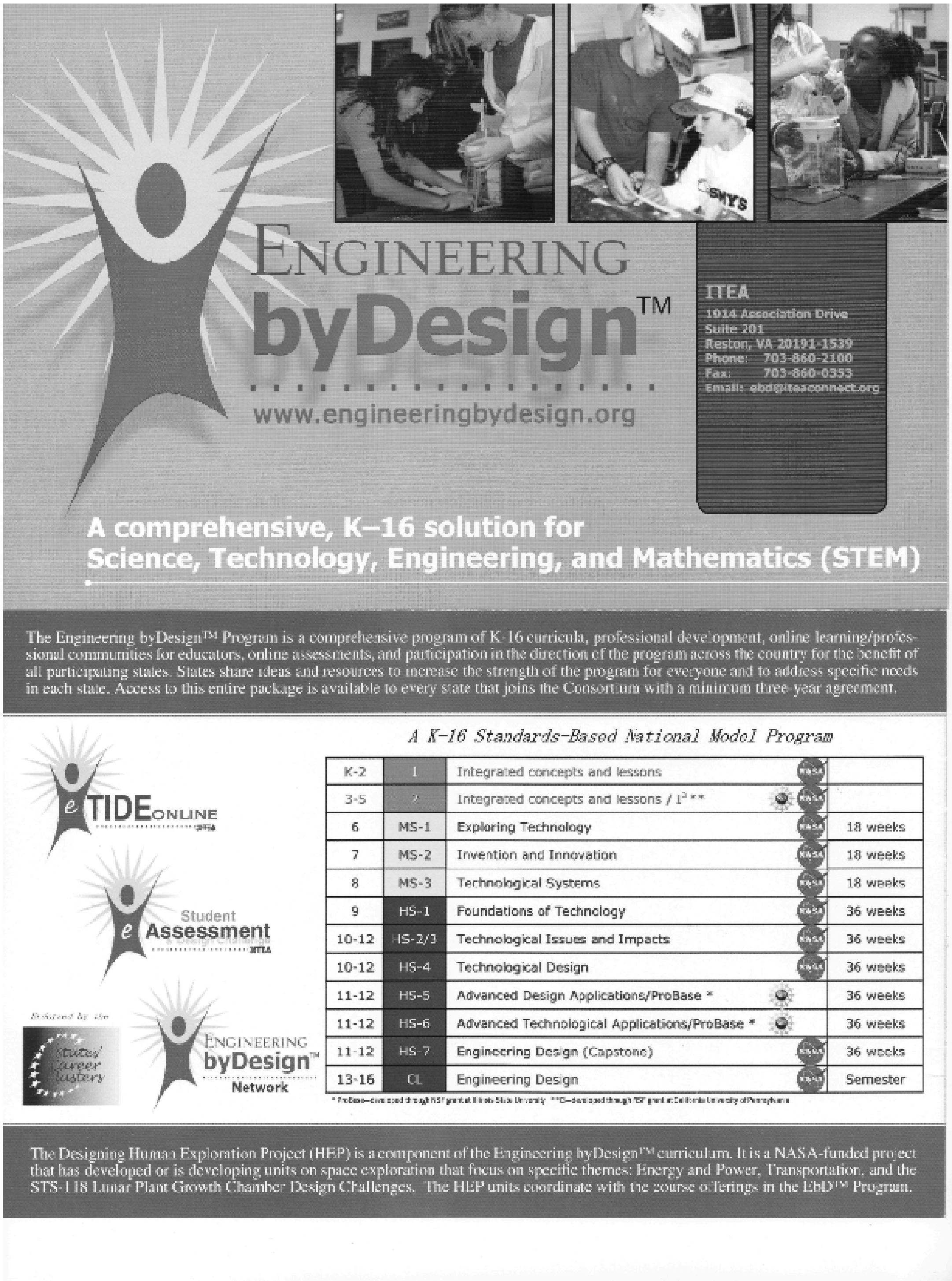
____

This concludes the questionnaire. Thank you for your participation in this survey.

Name: ________________________ School System: ______________________

APPENDIX D

***Engineering byDesign*™ Postcard**



ENGINEERING byDesign™

www.engineeringbydesign.org

ITEA
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Reston, VA 20191-1539
Phone: 703-860-2100
Fax: 703-860-0353
Email: ebd@iteaconnect.org

A comprehensive, K–16 solution for Science, Technology, Engineering, and Mathematics (STEM)

The Engineering byDesign™ Program is a comprehensive program of K-16 curricula, professional development, online learning/professional communities for educators, online assessments, and participation in the direction of the program across the country for the benefit of all participating states. States share ideas and resources to increase the strength of the program for everyone and to address specific needs in each state. Access to this entire package is available to every state that joins the Consortium with a minimum three-year agreement.

A K-16 Standards-Based National Model Program

K-2	1	Integrated concepts and lessons	
3-5	[illegible]	Integrated concepts and lessons / I[3] **	
6	MS-1	Exploring Technology	18 weeks
7	MS-2	Invention and Innovation	18 weeks
8	MS-3	Technological Systems	18 weeks
9	HS-1	Foundations of Technology	36 weeks
10-12	HS-2/3	Technological Issues and Impacts	36 weeks
10-12	HS-4	Technological Design	36 weeks
11-12	HS-5	Advanced Design Applications/ProBase *	36 weeks
11-12	HS-6	Advanced Technological Applications/ProBase *	36 weeks
11-12	HS-7	Engineering Design (Capstone)	36 weeks
13-16	CL	Engineering Design	Semester

eTIDE ONLINE

Student eAssessment

ENGINEERING byDesign™ Network

The Designing Human Exploration Project (HEP) is a component of the Engineering byDesign™ curriculum. It is a NASA-funded project that has developed or is developing units on space exploration that focus on specific themes: Energy and Power, Transportation, and the STS-118 Lunar Plant Growth Chamber Design Challenges. The HEP units coordinate with the course offerings in the EbD™ Program.

Note. *Engineering byDesign*™ Postcard (front and back view)